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(54) Method and apparatus for filling trays with rod-shaped articles

(57) Cylindrical rod-shaped articles (109) which carry or are about to carry seeds or cuttings, are transported by a conveyor (124) in a direction at right angles to their axes to a row forming station where they are picked-up and held in flutes at the underside of a suction head (131) to form a row. The suction head (131) is then lifted and a pusher (134) transfers the row, by moving the articles (109) axially, into an adjacent tray (2c) which has rows of spikes on which the articles are impaled or compartments for receiving discrete articles. If the seeds or cuttings are to be implanted subsequent to introduction of the articles into the tray, the exposed end face of each article is formed with a recess during or immediately after introduction into the tray. All the articles of a row are transferred in a single step and the tray is lowered to receive successive rows. The trays can be tilted from horizontal to vertical positions prior as well as subsequent to reception of the rows of articles.

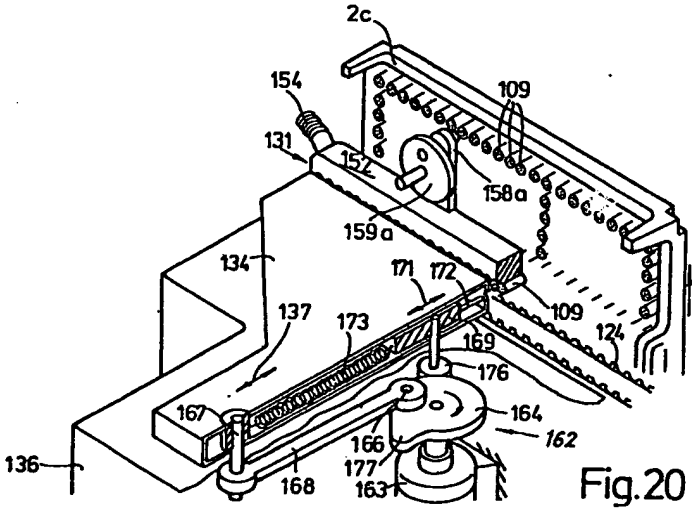

Fig.20

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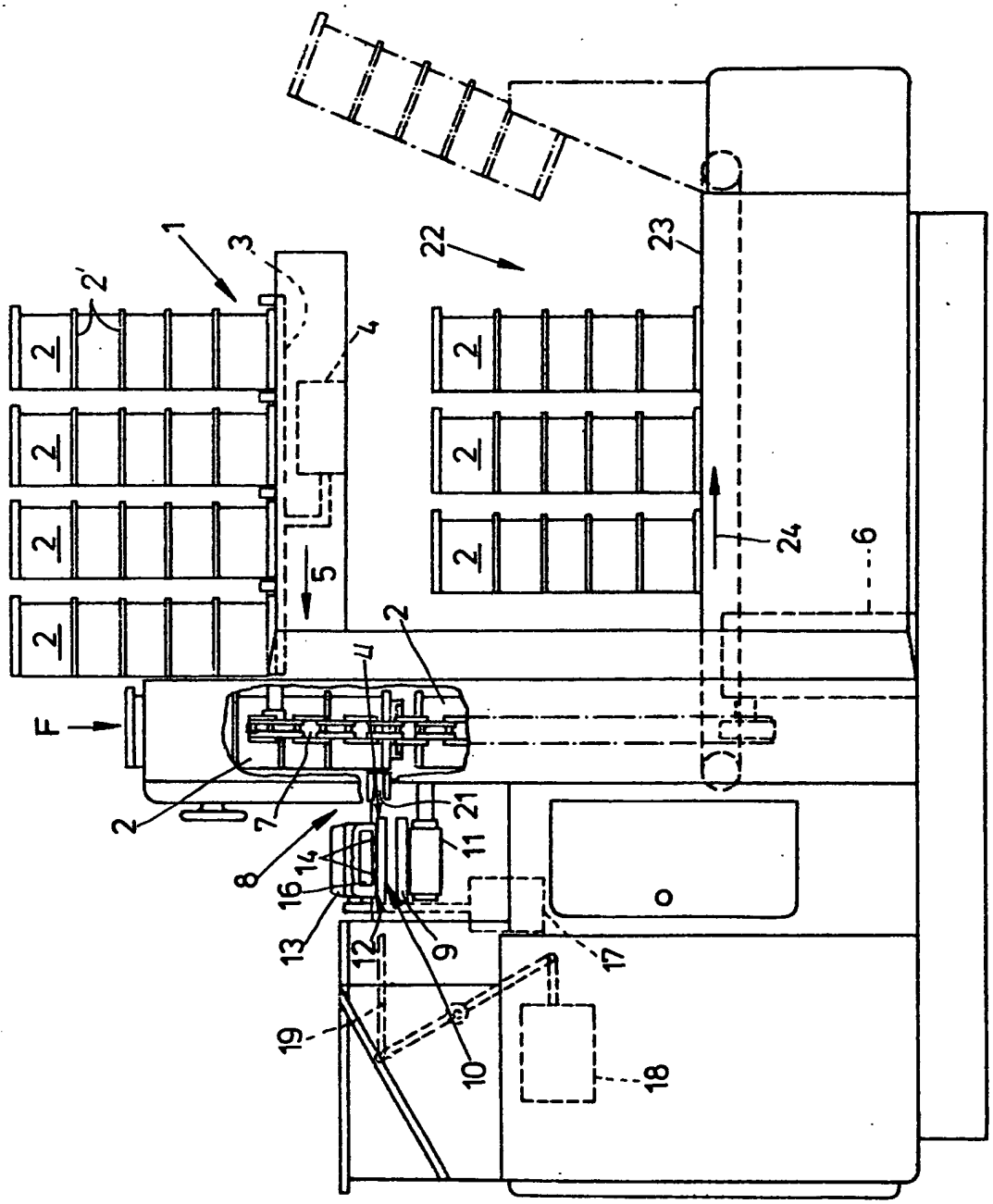

Fig.1

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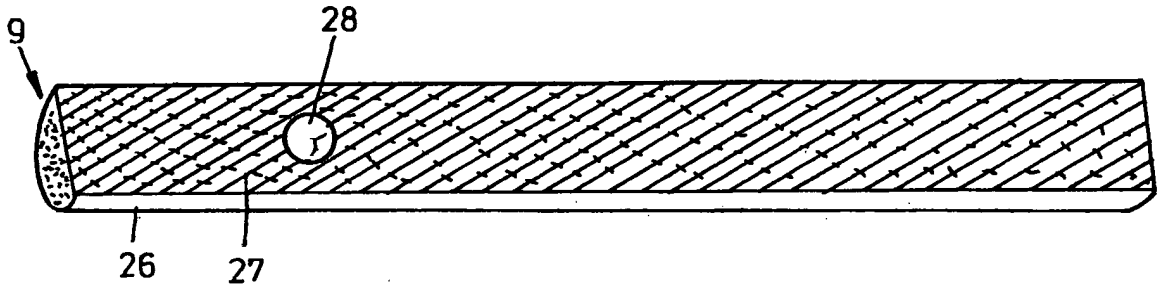
Fig.2



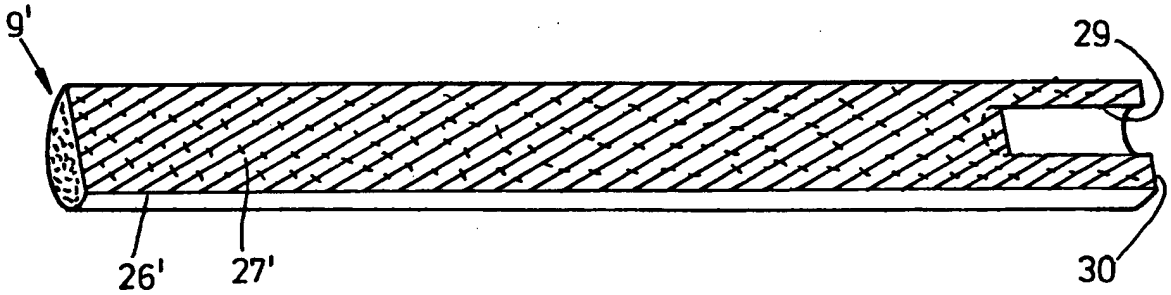


Fig.6

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Fig.4

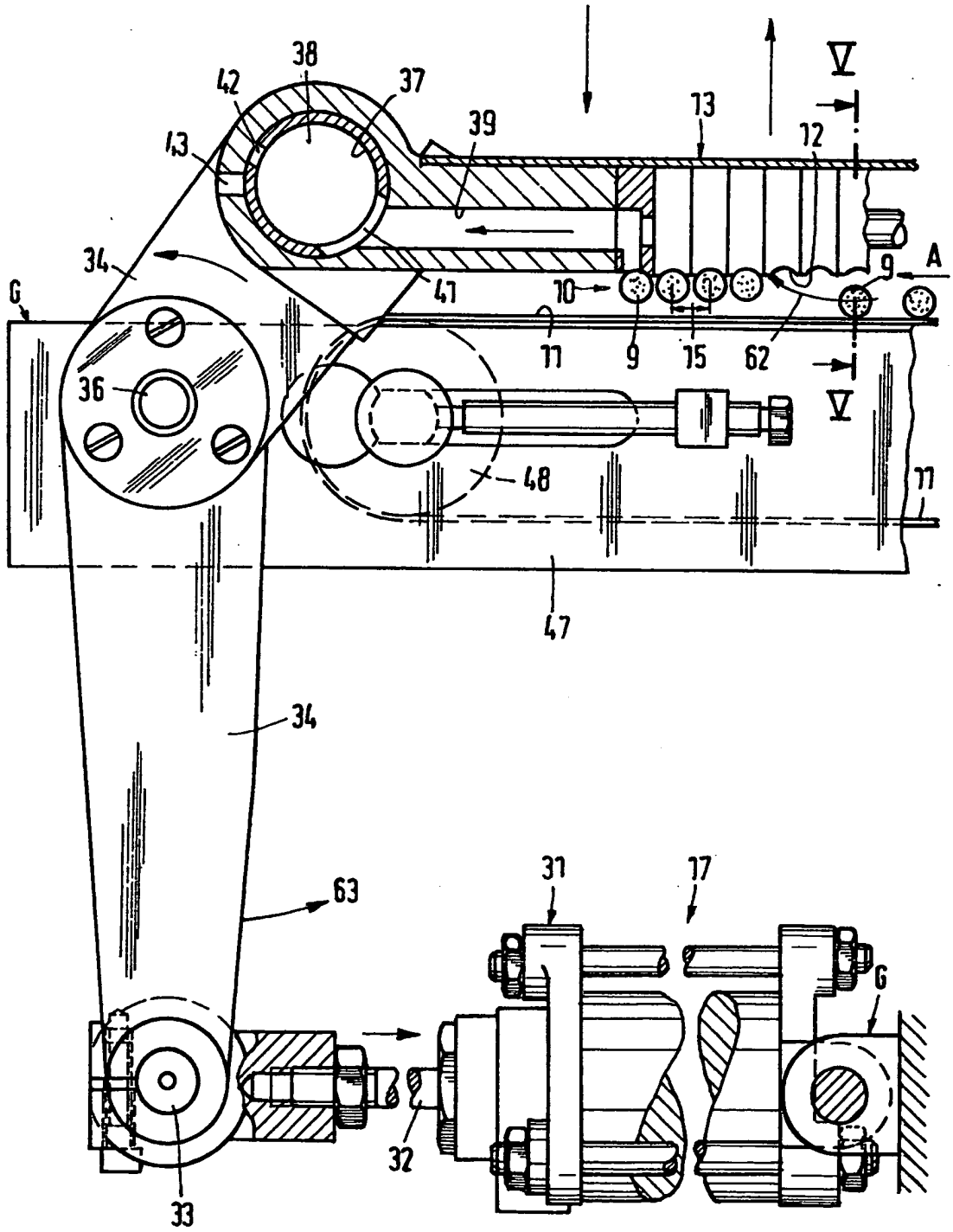

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Fig.3

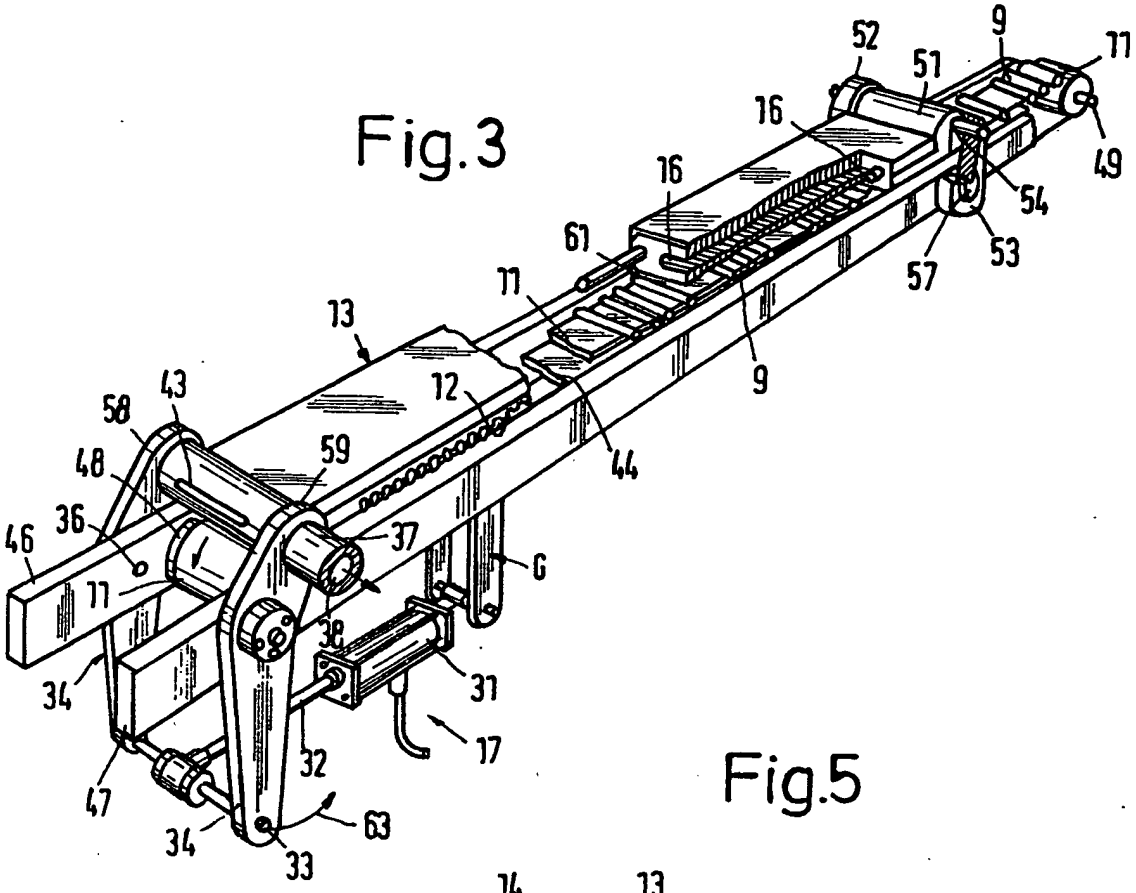
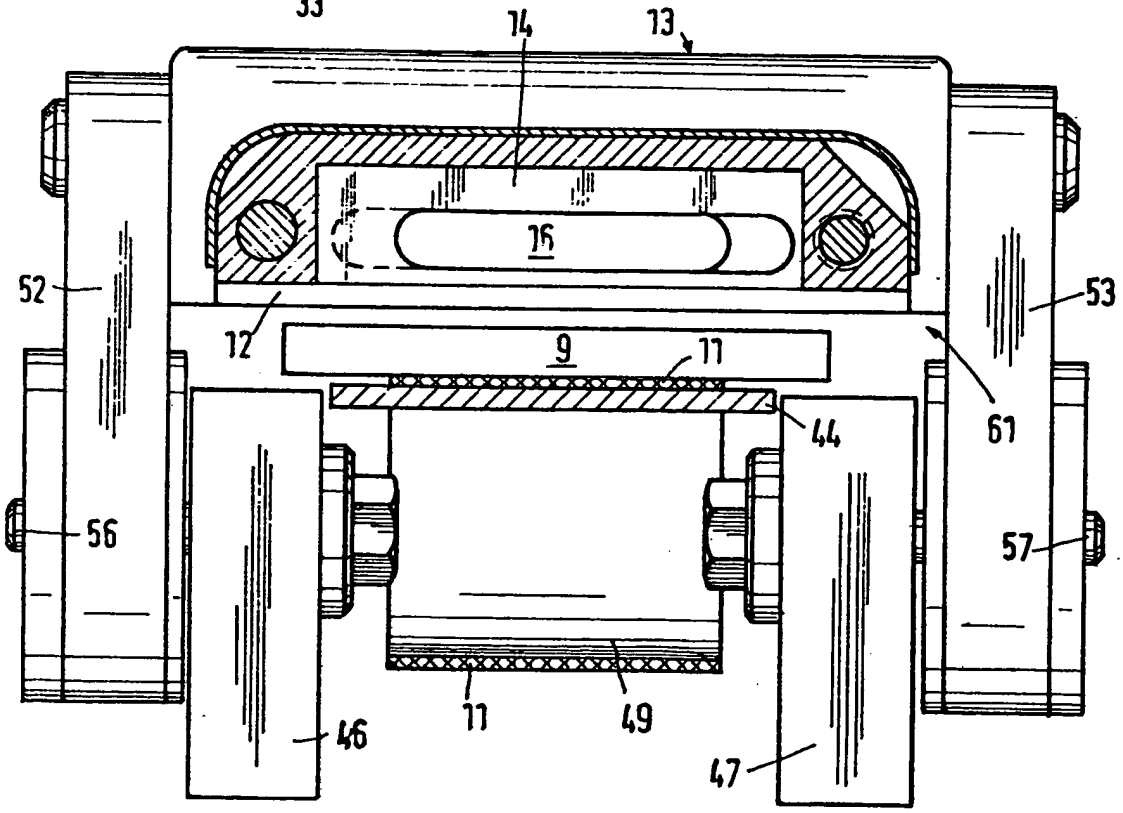


Fig.5



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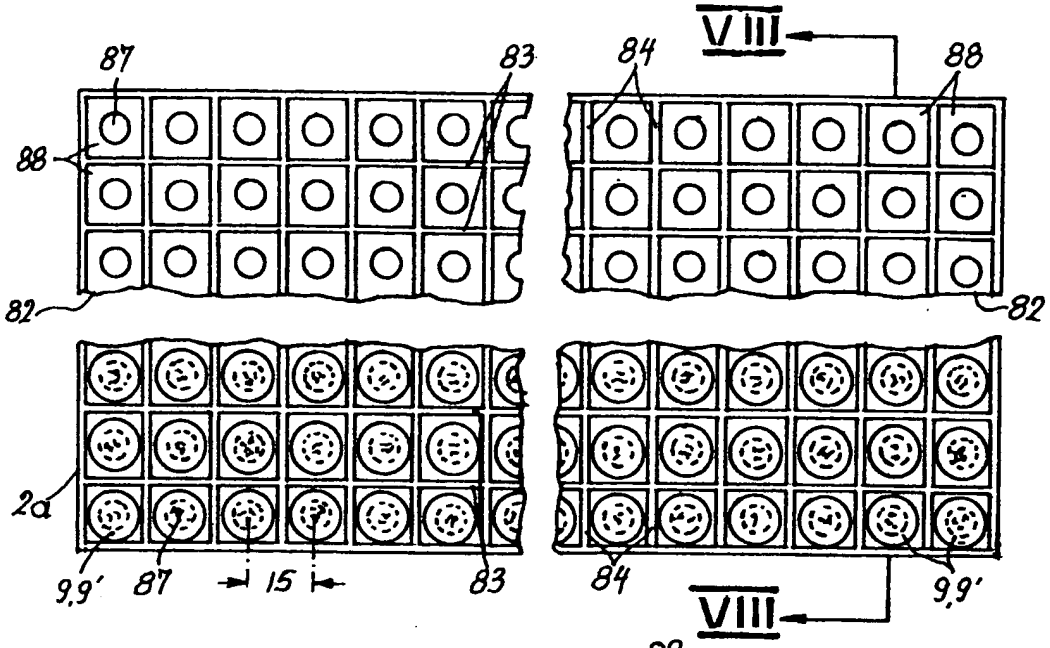

Fig.7

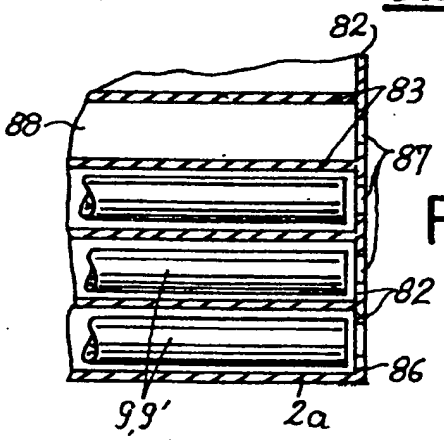

Fig.8

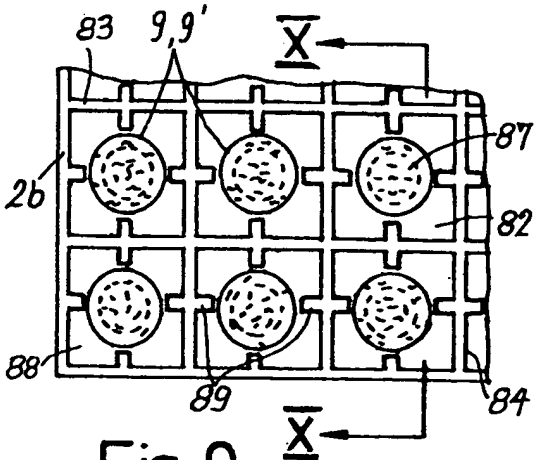

Fig.9

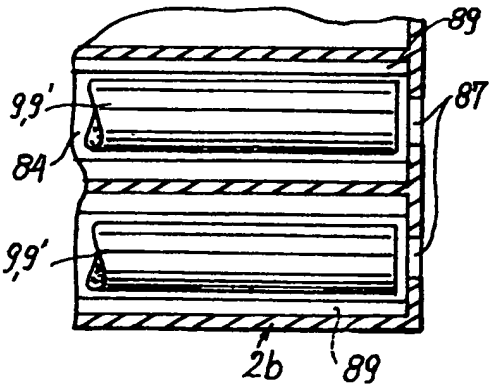

Fig.10

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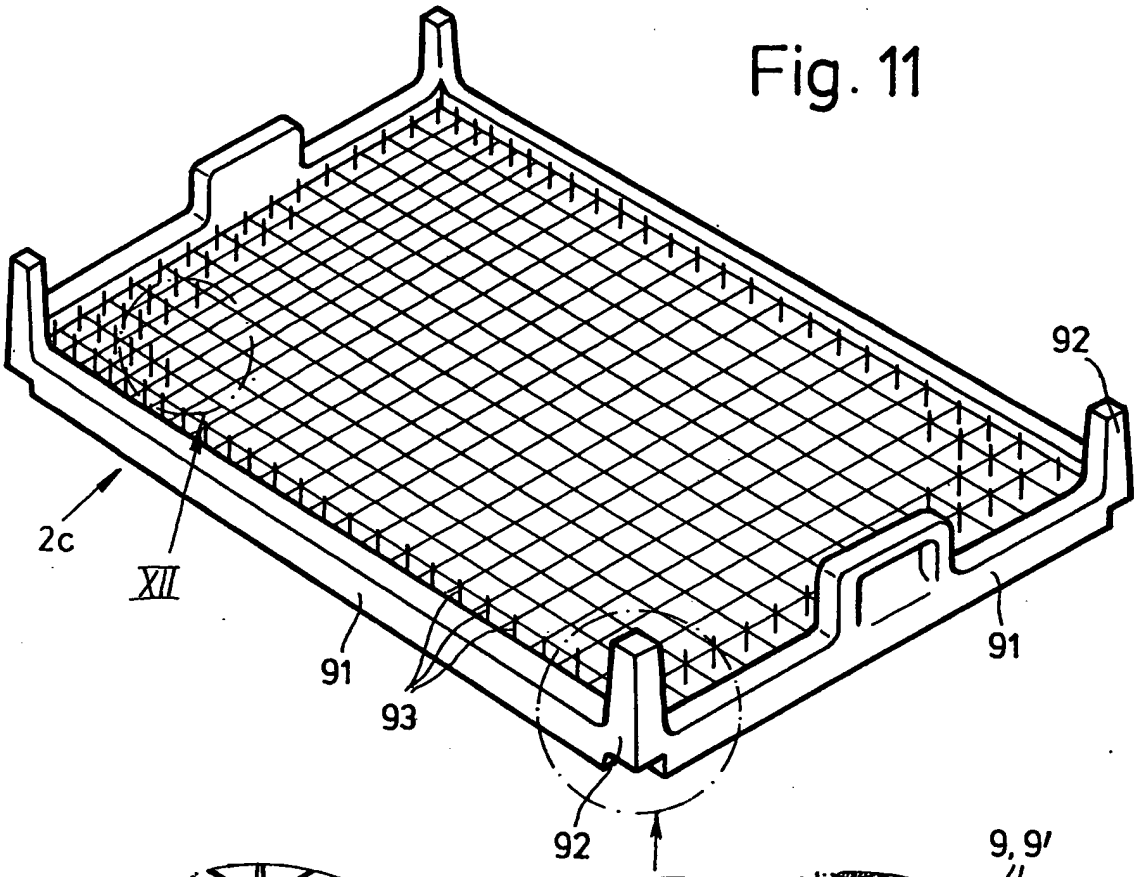
Fig. 11



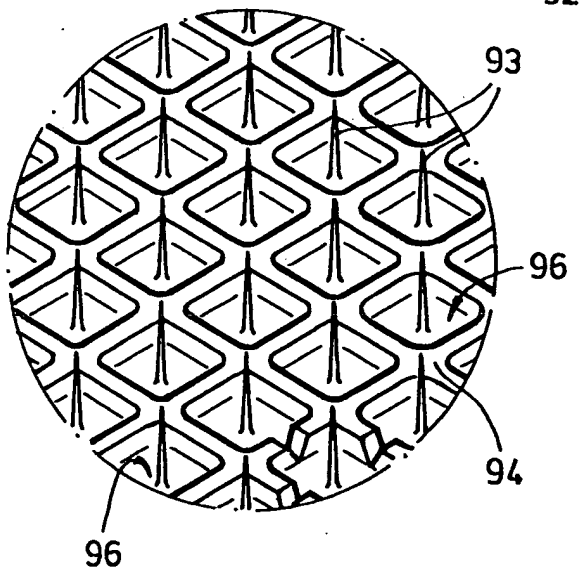


Fig. 12

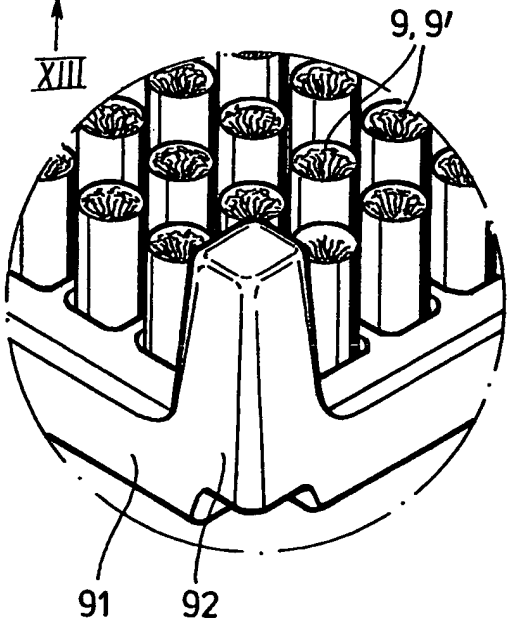


Fig. 13

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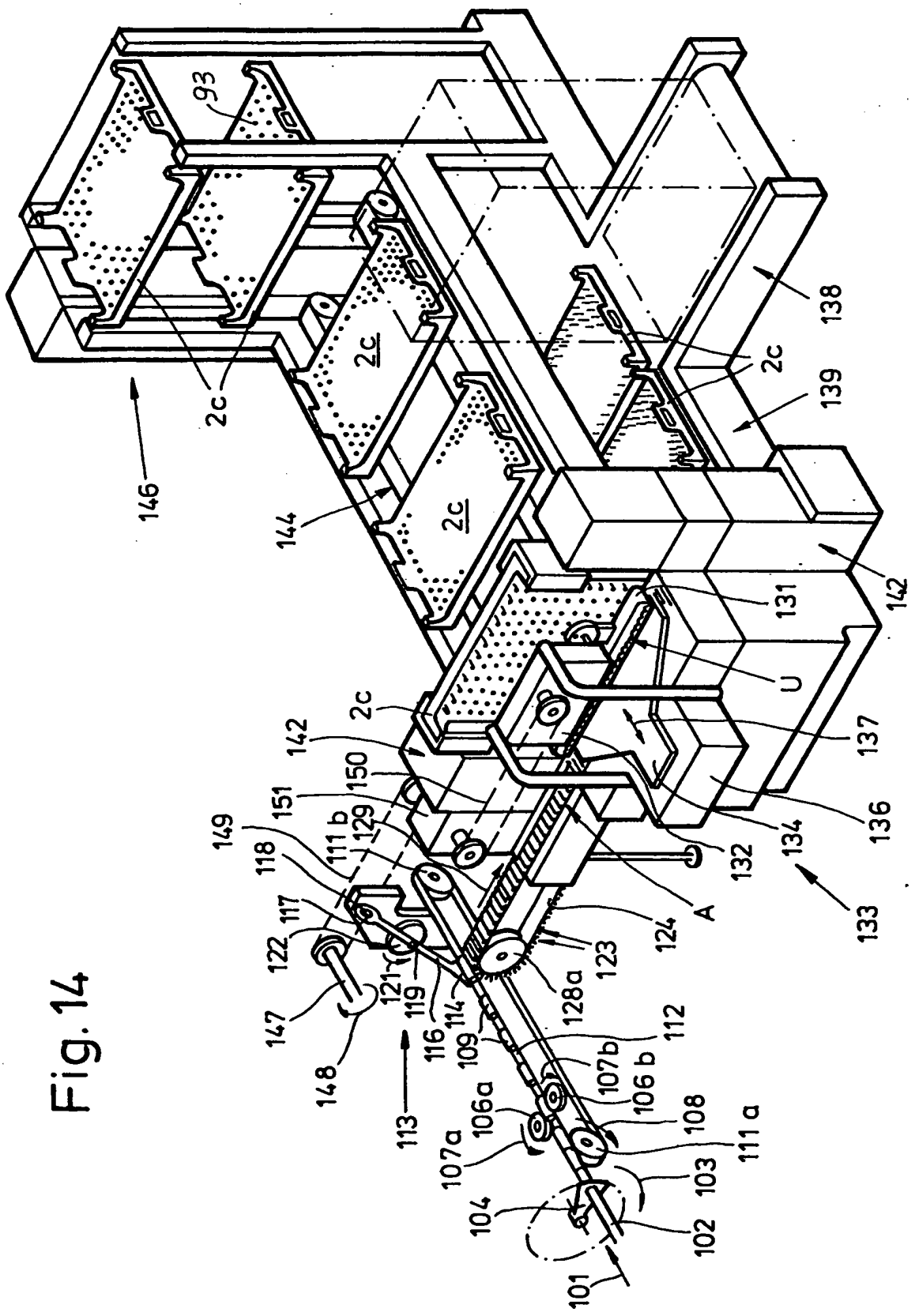

Fig. 14

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Fig.15

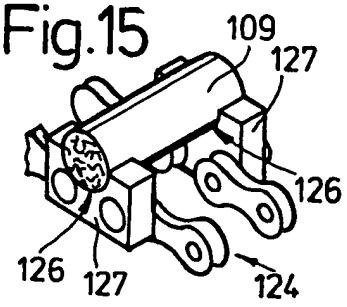

Fig.16

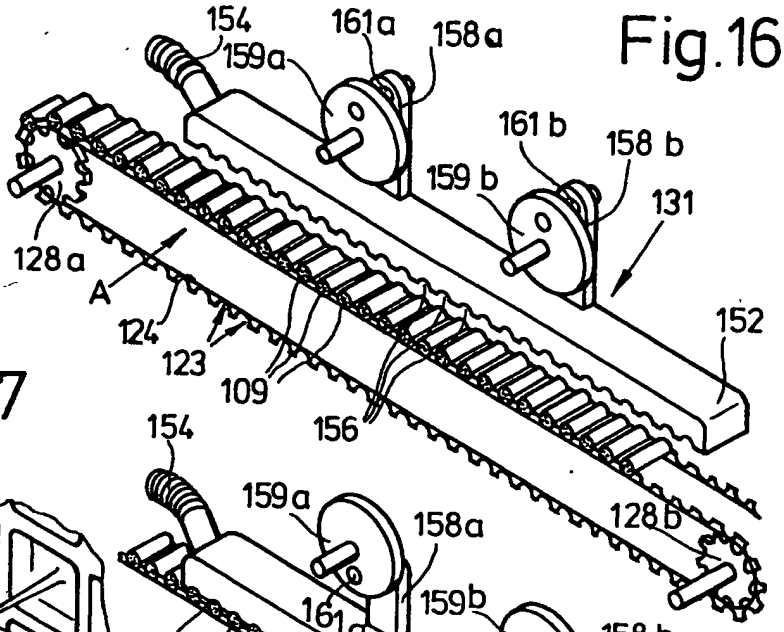

Fig.17

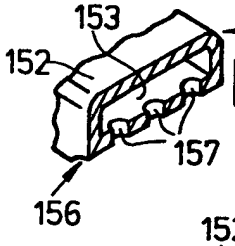

Fig.18

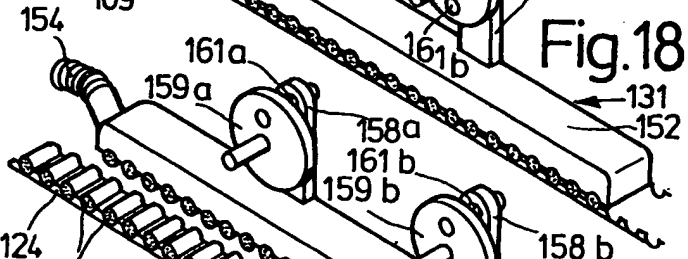

Fig.21

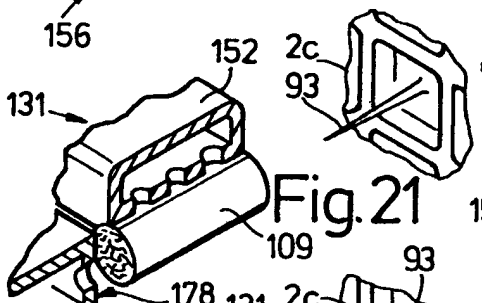

Fig.19

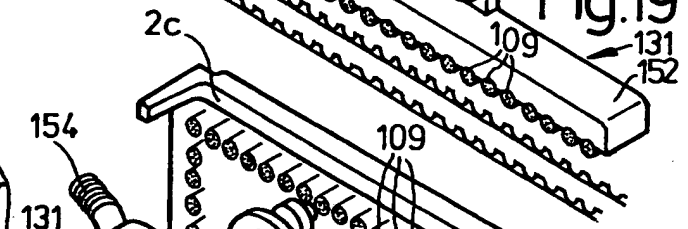

Fig.22

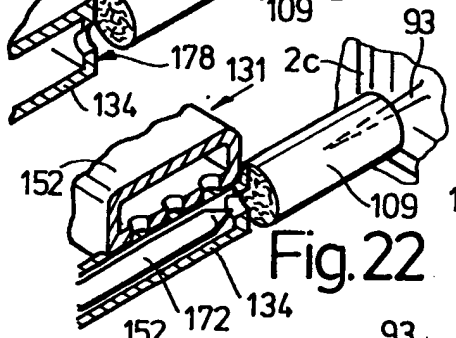

Fig.23

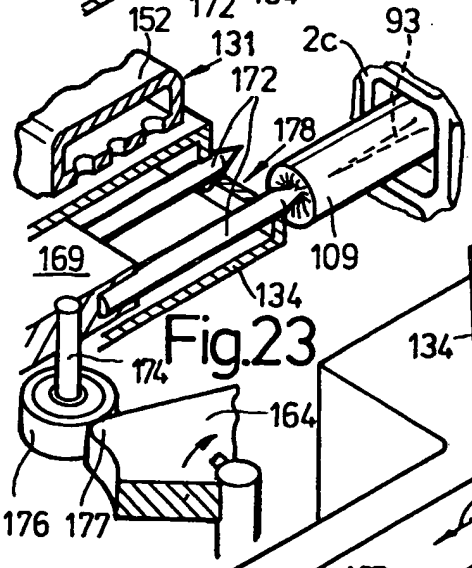

Fig.20

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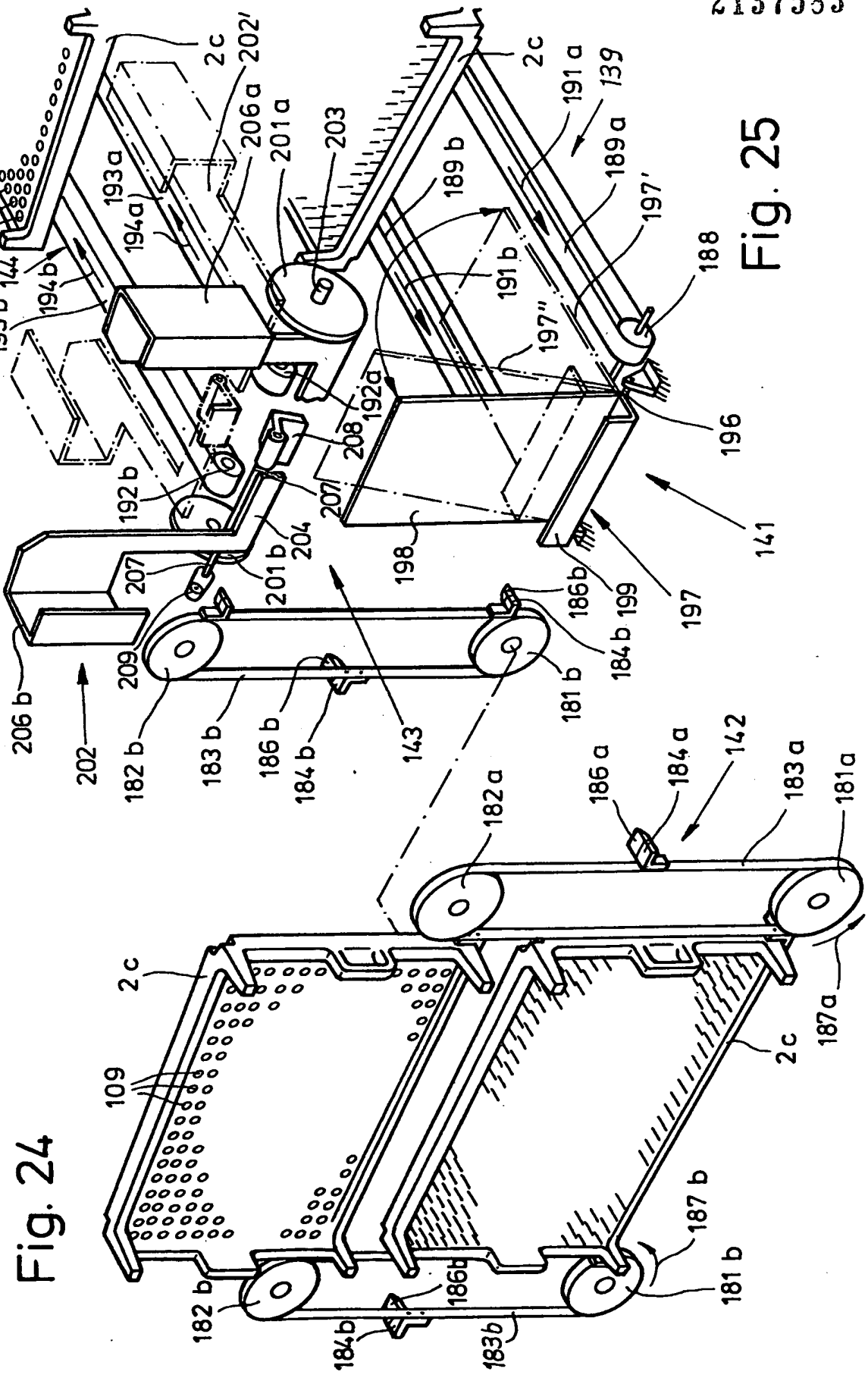

Fig. 24

Fig. 25

SPECIFICATION

Method and apparatus for manipulating seed carrying devices and the like

The present invention relates to a method and to an apparatus for manipulating devices for carrying seeds or cuttings (hereinafter called "seed carrying devices" or "devices" for short). More particularly, the invention relates to a method and apparatus for manipulating substantially rod-shaped and preferably cylindrical seed carrying devices wherein a tubular (preferably cylindrical) shell consisting of or containing paper or the like surrounds a mass of filler material which may or may not contain one or more seeds or one or more cuttings. Still more particularly, the invention relates to a method and apparatus for transferring seed carrying devices into containers, especially into trays wherein the devices are temporarily stored and wherein the seeds or cuttings in such devices can be caused to germinate or sprout prior to planting, e.g., in the field or in a nursery.

The term "filler material" is intended to embrace substances in which a seed or a cutting can germinate or grow roots, at least for a certain interval of time. Such materials can include peat, planting soil or similar substances with or without fillers, such as foams, and with or without fertilizers. The seed carrying devices can contain seeds or cuttings at the time of manipulation, i.e., already to and during transfer into containers or the seeds or cuttings can be inserted into the filler materials of such devices subsequent to confinement of the devices in the respective containers. If the seeds or cuttings are to be inserted subsequent to introduction of the respective seed carrying devices into a container, the filler materials of such devices can be provided with recesses in the form of blind holes or the like for convenient introduction of one or more seeds or one or more cuttings.

U.S. Pat. No. 3,456,386 (granted July 12, 1969 to Herbert K. Holden) discloses a seed carrying device which includes a water-stable fibrous mass gathered into an elongated shell and containing a plurality of plant seeds. This patent further discloses that such seed carrying devices can be manufactured in modified cigarette filter plug making machines.

German Offenlegungsschrift No. 30 49 576 proposes to connect cylindrical seed carrying devices, for example, devices of the type disclosed in the patent to Holden, by means of a band so that the devices are held at a predetermined distance from one another. This German publication further discloses that the seeds in the respective devices can be caused to germinate at selected times. After a certain interval of cultivation in the respective shells, the growing shoots are planted in the field whereby the band determines the mutual spacing of planted shoots.

A drawback of presently known proposals is that no provision is made from temporary storage of large or extremely large numbers of seed carrying devices in a small area and in such a way that groups of properly distributed seed carrying devices can be readily manipulated prior to start of germination of seeds or prior to growing of cuttings as well as during such cultivation and preparatory to planting of sufficiently grown plants or shoots in the field, in a nursery or anywhere else outside of the respective shells.

One feature of the invention resides in the provision of a method of storing pluralities of substantially rod-like carrying devices for incipient plants (including seeds, cuttings and other forms of existent or future plants which occupy little room) in successive containers (especially flat trays) wherein the plants can be or are caused to grow. The method comprises the steps of advancing a series of devices transversely along a predetermined path (for example, along a horizontal path), gathering successive groups of the thus advanced or advancing devices into a succession of rows of equidistant parallel devices, and introducing the devices of such rows into containers including moving the devices longitudinally. The introducing step can further include simultaneously inserting all of the devices of a full row into the respective container.

The method preferably further comprises the step of maintaining the introduced carrying devices in the respective containers in spaced-apart positions. To this end, the method can comprise the step of establishing in each container a discrete compartment (e.g., a discrete cell) for each of the carrying devices therein. Alternatively, the method can comprise the step of impaling each introduced carrying device in the respective container to thereby fix the impaled device in a predetermined position in the interior of or on or in the container.

If the seeds or cuttings are to be introduced into the filler materials of the respective carrying devices subsequent to insertion of such devices into the containers, that end face of each carrying device which faces away from the bottom of the container is provided with a recess (for example, a blind hole) which is ready to receive one or more seeds or one or more cuttings. The making of such recesses can take place during transfer of carrying devices into a container or subsequent to introduction of such devices into the corresponding container. The incipient plants (such as seeds or cuttings) are thereupon introduced into the respective recesses while the corresponding carrying devices are already properly installed and held in their container.

The advancing step can comprise continuously conveying the carrying devices of the aforementioned series along the predetermined path, and the gathering step then includes accumulating the oncoming foremost carrying devices of the series into the succession of rows in a predetermined portion of such path and removing each freshly accumulated row from the path so as to enable the oncoming devices to enter such portion of the path for the accumulation of the next-following row. Such portion of the path is or can be substantially horizontal and is disposed at a predetermined level. The removing step then preferably includes shifting each freshly accumulated row of carrying devices to a level other than (preferably above) the predetermined level.

The advancing step can include conveying a single layer of parallel carrying devices along the predetermined path, and the gathering step can include pneumatically lifting successive foremost carrying devices from such path into a second path and holding successive lifted carrying devices next to one another until the accumulation of the respective row is completed. The lifting step includes or can include raising the carrying devices by suction, and the holding step can include maintaining the lifted devices next to one another by suction in discrete flutes or analogous receiving means of a row forming unit, e.g., an elongated suction head.

Still further, the advancing step can comprise conveying a single layer of equidistant carrying devices along the predetermined path, and the gathering step then includes transferring path, and the gathering step then includes transferring rows containing predetermined numbers of carrying devices from the leading end of the layer in the predetermined path into a second path while the mutual spacing of the transferred carrying devices remains unchanged. The introducing step then includes advancing successive rows of carrying devices along the second path and into the respective containers while leaving the mutual spacing of the carrying devices in such rows unchanged. The method then further comprises the step of holding the carrying devices of the rows in the respective containers without changing the mutual spacing of the devices in such rows. In other words, the mutual spacing of the carrying devices can be established in the predetermined path along which the carrying devices are caused to advance toward the row forming station, and such mutual spacing thereupon remains intact during further manipulation of the carrying devices as well as in the interior of the respective containers. In accordance with the presently preferred embodiment of the improved method, the rows of carrying devices are at least substantially horizontal and the containers are arranged to receive arrays consisting of several superimposed rows of carrying devices. The method then further comprises the step of moving the container which is in the process of receiving an array of rows in stepwise fashion so as to provide room for introduction of successive rows one above or one below the other.

The introducting step can include moving the container which is in the process of receiving rows of carrying devices in stepwise fashion transversely of the longitudinal directions of the carrying devices in the rows, and moving the filled container in the longitudinal direction of the carrying devices therein. Such mode of transporting containers ensures that the containers can be stored, stepwise advanced and removed in a small area. As a rule, the container which is in the process of receiving rows of carrying devices is moved in stepwise fashion in a vertical plane through a filling station in such a way that it carries out a step during each interval between the admission of two successive rows of carrying devices. It is further desirable or advantageous to change the orientation of successive filled containers. Such orientation changing step preferably includes tilting each filled container from a substantially upright position in which the carrying devices therein are at least substantially horizontal to a substantially prone or horizontal position in which the carrying devices therein are at least substantially vertical. A succession of containers can be transported along a predetermined path, and such step includes or can include advancing empty containers in prone position and advancing the containers which are in the process of being filled with rows of carrying devices in upright position. In other words, a change in orientation of containers can also take place at a time when or shortly before a freshly delivered empty container is about to receive the first row of preferably equidistant carrying devices.

Another feature of the invention resides in the provision of an apparatus for storing pluralities of substantially rod-like carrying devices for incipient plants in containers wherein the plants can be, or are caused to, grow. The apparatus comprises conveyor means for advancing a series of carrying devices along a predetermined (preferably horizontal or nearly horizontal) path wherein the devices move transversely of their longitudinal direction, means for converting successive conveyed carrying devices into rows each of which contains a predetermined number of preferably equidistant parallel carrying devices, and means for transferring pluralities of successively formed rows into successive containers including means of moving the rows in the longitudinal direction of the respective carrying devices. The transferring means preferably includes means for simultaneously introducing all carrying devices of a complete row into the respective container. If the carrying devices do not contain seeds or cuttings at the time of transfer into the respective containers, the transferring means preferably includes or carries means for forming a recess in one end face of each carrying device during transfer of the respective row into a container or immediately after completion of such transfer. Such transferring means can include a reciprocable pusher which serves to transfer a complete row of carrying devices into a container, and the recess forming means then preferably includes a plurality of tools (such as pointed pins) which are movable with as well as relative to the pusher and each of which is arranged to penetrate into the one end face of a discrete carrying device during transfer of the respective row of such devices.

The converting means can comprise means for gathering predetermined numbers of carrying devices into rows adjacent to a predetermined portion of the path which is defined by the conveying means, and means for moving the gathering means relative to such portion of the path so that the freshly accumulated row does not interfere with introduction of oncoming carrying devices into the aforementioned portion of the path. The moving means can include means for shifting the carrying devices of full rows transversely of such carrying devices through a distance which at least equals the diameter of a carrying device. The gathering means of such apparatus can comprise a suction head whose underside is provided with a row of receptacles (for example, flutes), one for each carrying

device of a row, and means for attracting carrying devices from the aforementioned portion of their path into the receptacles by suction. The containers can be of the type having equidistant portions (for example, cells) allotted for reception of discrete devices. The mutual spacing of the centers of such equidistant portions preferably matches the mutual spacing of neighboring receptacles at the underside of the suction head. This ensures that the mutual spacing of the carrying devices need not be changed during transfer from the receptacles at the underside of the suction head into the selected cells or other receiving portions of the corresponding container. The suction head is preferably provided with an elongated suction chamber and has ports which communicatively connect the suction chamber with each of the receptacles.

The conveyor means can include equidistant receiving means (for example, flutes or cradles) for discrete carrying devices, and the converting means then preferably comprises means for removing from the path complete rows of equidistant carrying devices in a single step. The mutual spacing of such equidistant carrying devices on the conveyor means preferably matches the mutual spacing of equidistant portions in the containers. The transferring means then includes means for introducing successive rows of carrying devices into the corresponding containers without altering the mutual positions of the carrying devices in such rows.

The suction head is preferably arranged to advance along an endless second path having a first portion in which the underside of such suction head is adjacent to the aforementioned portion of the predetermined path for the carrying devices on the conveyor means and, at such time, the suction head has a component of movement in the direction of transport of carrying devices by the conveyor means. The second path further comprises a second portion in which the suction head is preferably arrested for a certain interval of time, and the suction head is further provided with means for attracting predetermined numbers of carrying devices from the path on the conveyor means to the underside of the suction head while the latter is disposed in the first portion of the second path. The means for introducing the thus transferred row of carrying devices is preferably arranged to remove a row of carrying devices from the underside of the suction head while the suction head is held in the second portion of the second path. As mentioned above, the underside of the suction head can have a row of equidistant flutes for discrete carrying devices, and the advancing means then includes means for temporarily arresting the suction head in the second portion of the second path so that the suction head is invariably at a standstill during transfer of a row of carrying devices from its flutes into a container.

The apparatus preferably further comprises means for transporting containers along a further path having a portion in which the containers move stepwise during intervals between introduction of successive rows of carrying devices into their interior. Such transporting means can comprise means for moving successive filled containers in the longitudinal direction of the carrying devices which are confined therein. The transporting means can further include means for changing the orientation of successive filled containers. Such orientation changing means can include means for moving each filled container from an upright position in which the carrying devices therein are substantially horizontal to a prone (e.g., exactly horizontal) position in which the carrying devices therein are substantially vertical. Such transporting means further comprises means for moving filled containers in a direction at right angles to the longitudinal directions of the carrying devices in its interior. The transporting means can define a filling station wherein the containers are filled with rows of rod-shaped carrying devices, and such transporting means then further comprises means for delivering empty containers to the filling station. The orientation of each empty container can be changed not later than on arrival at the filling station.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

Figure 1 is an elevational view of an apparatus which embodies one form of the invention and wherein the containers which are in the process of receiving rows of carrying devices are caused to descend stepwise at a filling station next to the conveyor which delivers a single layer of parallel carrying devices;

Figure 2 is an enlarged central longitudinal sectional perspective view of a rod-shaped carrying device which can be manipulated in the apparatus of Figure 1;

Figure 3 is a perspective view of a suction head which is utilized in the apparatus of Figure 1 to gather successive rows of equidistant parallel rod-shaped carrying devices;

Figure 4 is an enlarged fragmentary longitudinal vertical sectional view of a portion of the structure which is shown in Figure 3;

Figure 5 is an enlarged fragmentary transverse vertical sectional view as seen in the direction of arrows from the line V-V of Figure 4;

Figure 6 is a perspective longitudinal sectional view of a modified carrying device which can be manipulated in the apparatus of the present invention;

Figure 7 is a fragmentary plan view of a container which can be filled in the apparatus of Figure 1;

Figure 8 is a fragmentary sectional view as seen in the direction of arrows from the line VIII-VIII of Figure 7;

Figure 9 is a fragamentary plan view of a modified container;

Figure 10 is a fragmentary sectional view as seen in the direction of arrows from the line X-X of Figure 9;

Figure 11 is a perspective view of a third con-

tainer;

Figure 12 is an enlarged perspective view of a detail within the phantom-line circle XII in Figure 11;

Figure 13 is an enlarged perspective view of a detail within the phanton-line circle VIII in Figure 11;

Figure 14 is a perspective view of a modified apparatus which can be utilized to fill trays with carrying devices of the type shown in Figure 2 or 6;

Figure 15 is an enlarged fragmentary perspective view of a detail of a chain conveyor which is utilized in the apparatus of Figure 14;

Figure 16 is an enlarged perspective view of a suction head which is utilized in the apparatus of Figure 14;

Figure 17 is an enlarged fragmentary perspective view of the suction head which is shown in Figure 16;

Figure 18 illustrates the suction head of Figure 16 in a different position;

Figure 19 illustrates the suction head of Figures 16 and 18 in a third position;

Figure 20 is an enlarged perspective view of the means for introducing rows of freshly gathered carrying devices into a container which is held in upright position at the filling station;

Figure 21 illustrates on a larger scale a portion of the structure which is shown in Figure 20, a carrying device being about to be transferred from the suction head into the allotted portion of the adjacent container;

Figure 22 illustrates the structure of Figure 21 during a further stage of transfer of a carrying device into the container;

Figure 23 illustrates the structure of Figures 21 and 22 during the final stage of transfer of a carrying device into the container and during the making of a recess therein;

Figure 24 is an enlarged perspective view of a portion of the means for transporting containers in the apparatus of Figure 14; and

Figure 25 is a perspective view of another portion of the means for transporting containers in the apparatus of Figure 14.

Referring first to Figure 1, empty containers 2 (hereinafter called trays for short) are held in a position of readiness at a station 1 which stores a supply of empty trays. Successive foremost empty trays 2 are moved forwardly in the direction of arrow 5 by a combined lifting and advancing mechanism 3 receiving motion from a prime mover 4. The mechanism 3 advances successive empty trays 2 into the range of a tray lowering conveyor 7 which operates in stepwise fashion and receives motion from a prime mover 6. The purpose of the lowering conveyor 7 is to move the tray or trays 2 thereon stepwise in a vertical plane F along a filling station 8 where the tray is gradually filled with rows 10 of carrying devices 9. The filling station 8 is located in the vertical plane F in front of the foremost empty tray 2 at the station 1.

The filling station 8 receives carrying devices 9 of the type shown in Figure 2 or 6 from a belt conveyor 11 having an upper reach disposed in a horizontal plane and defining for a succession of parallel rod-shaped carrying devices 9 a horizontal path a portion of which is adjacent to the filling station 8. The upper reach of the conveyor 11 extends at right angles to the plane of Figure 1. The arrow A indicates in Figure 4 the direction of sidewise advancement of carrying devices 9 with the upper reach of the conveyor 11. The devices 9 on the conveyor 11 need not be equally spaced apart from one another; such devices are caused to move at right angles to their respective axes into the space below a suction head 13 which serves to gather predetermined numbers of successively delivered carrying devices 9 into rows 10 of equidistant parallel carrying devices. To this end, the underside of the suction head 13 is formed with a row of parallel receiving means in the form of flutes 12 each of which communicates with a suction port 14 (Figure 5) serving to connect such flute with a suction chamber 16 extending longitudinally of the suction head 13 at a level above the flutes 12. The distance between the centers of each pair of neighboring flutes 12 is the same; this is indicated in Figure 4 by the reference character 15. The arrangement is such that suction in the foremost port 14 of the suction head 13 is more pronounced than in the next-following suction port 14, and so forth. This ensures that the foremost carrying device 9 on the upper reach of the conveyor 11 is automatically lifted into the foremost flute 12, that the next carrying device 9 is automatically lifted into the second flute 12 wherein the suction is then more pronounced than in the third foremost flute 12, and so forth. In other words, the suction head 13 can automatically accumulate rows 10 of equidistant carrying devices 9 irrespective of the mutual spacing of carrying devices on the upper reach of the conveyor 11. This is fully described in commonly owned U.S. Pat. No. 3,245,558 granted Aprii 22, 1966 to Kochalski et al. which is incorporated herein by reference.

The reference character 17 denotes in Figure 4 a drive which serves to automatically lift the suction head 13 above and away from the upper reach of the conveyor 11 when each of its flutes 12 contains a carrying device 9. The thus shifted suction head 13 raises the freshly formed row 10 through a distance which suffices to ensure that the next-following carrying devices 9 on the upper reach of the conveyor 11 can advance in the direction of arrow A toward the foremost flute 12. Such mode of operation ensures that the formation of a fresh row 10 can begin immediately after the fully assembled row 10 is transferred from the flutes 12 into a container 2 at the filling station 8 and after the suction head 13 has thereupon reassumed its lower position under the action of the drive 17. The arrow A further indicates the plane in which the lifted carrying devices 9 are located at the underside of the suction head 13 while the suction head is held in its lower position. When the suction head 13 is moved to its raised position, the row 10 of carrying devices 9 in its flutes 12 is located in a plane U which is indicated in Figure 1 and in which the carrying devices 9 of the thus lifted row 10 remain during introduction into the adjacent empty or partically filled tray 2. As a rule, it suffices to establish between the planes A and U a distance which equals or slightly exceeds the diameter of a

carrying device 9. The means for transferring successive rows 10 of carrying devices 9 from the flutes 12 at the underside of the suction head 13 into the container or tray 2 at the filling station 8 comprises a transfer member in the form of a pusher 19 receiving motion from a drive 18 and arranged to move back and forth in the plane U at a level above the upper reach of the conveyor 11. The devices 9 of a row 10 which is being transferred from the suction head 13 into the adjacent tray 2 are caused to pass through a suitable mouthpiece 21 which is located to the right of the suction head, as viewed in Figure 1, and serves to ensure that the orientation of the devices 9 during transfer remains unchanged as well as that the mutual spacing of the devices 9 remains the same as during dwell in the flutes 12.

As will be described hereinafter, each tray 2 is provided with portions in the form of cells, compartments or the like serving to receive discrete carrying devices 9 so that the mutual spacing of neighboring devices in the partially or completely filled tray is the same in each and every one of a short or long series of successive trays.

When the transfer of a full row 10 of carrying devices 9 into the tray 2 at the filling station 8 is completed, the drive 6 lowers such tray through a distance which equals or exceeds the diameter of an article 9 so that the tray provides room for introduction of the next complete row 10. As a rule, the extent of downward movement of a tray 2 at the filling station 8 upon reception of a row of articles 9 will equal the diameter of an article 9 plus half the distance 15 shown in Figure 4. This ensures that the distance between the devices 9 in two superimposed rows 10 in the interior of a tray 2 is the same as the distance between the neighboring devices 9 of a given row 10.

The pusher 19 is retracted by the drive 18 as soon as the introduction of a fresh row 10 from the flutes 12 into the tray 2 at the filling station 8 is completed so that the suction head 13 can be lowered by the drive 17 back to the position which is shown in Figure 4 whereby the formation of a fresh row 10 can begin. During the interval which is taken up by the lifting and lowering of the suction head 13, the foremost carrying device 9 on the upper reach of the conveyor 11 has nearly advanced to the foremost flute 12 so that the foremost flute can receive such device immediately after the suction head 13 reassumes the position of Figure 4. In this manner, the intervals between the formation of successive rows 10 of equidistant devices 9 are practically zero.

When the tray 2 at the filling station 8 receives a predetermined number of successive rows 10, the prime mover 4 sets in motion the mechanism 3 which advances the foremost empty tray 2 at the station 1 into the range of the lowering conveyor 7 in the plane F so that such foremost empty tray can begin to descend and to move its lowermost portion into register with the mouthpiece 21 for reception of the first row 10 of carrying devices 9.

When the freshly filled tray 2 reaches the level of a station 22 for accumulation and temporary storage of a certain number of filled trays 2, such freshly filled tray is removed from the vertical plane F in the direction of arrow 24 by an intermittently operated belt or chain conveyor 23. The conveyor 23 not only serves to remove filled trays from the station 8 but also constitutes a magazine for temporary storage of a selected number of filled trays 2. By the same token, the mechanism 3 can be considered to constitute a magazine for storage of a selected number of empty trays 2. The supply of empty trays 2 at the station 1 can be replenished intermittently, at regular or at irregular intervals, as long as the replenishment takes place at intervals which are shorter than those required to completely deplete the supply of empty trays on the mechanism 3. The non-referenced mechanism which is shown by phantom lines at the right-end of the conveyor 23 in the lower right-hand portion of Figure 1 constitutes a device which can remove successive filled trays 2 from the upper reach of the conveyor 23 for delivery to storage or to another destination.

Each of the trays 2 has a bottom wall provided with longitudinally and transversely extending partitions or intermediate walls (not shown in Figure 1) which subdivide the interior of such tray into numerous rows of compartments or cells so that each such row of compartments or cells can receive a row 10 of carrying devices 9. In other words, each tray 2 contains predetermined portions each of which is allotted for reception and retention of a discrete device 9 therein. In this manner, the mutual spacing of carrying devices 9 in a tray 2 can remain unchanged for as long as desired. The horizontal partitions of the tray 2 which is held in upright position (with its bottom wall in a vertical plane and remote from the conveyor 11) serve to separate successively introduced rows 10 from one another, whereas the vertically extending partitions or walls in such tray serve to separate the neighboring carrying devices 9 of each row 10 from each other. The exact configuration of the compartments or cells in the trays 2 can be selected practically at will. Such compartments or cells can have a triangular, rectangular, square, hexagonal or other polygonal cross-sectional outline. If the outline of the cells or compartments is hexagonal, the walls or partitions which form such cells or compartments can resemble the walls of a honeycomb. It is also possible to form compartments or cells having a circular outline, preferably bounded by conical surfaces which flare outwardly so as to facilitate introduction of the leading ends of carrying devices 9 into such compartments or cells.

Figure 2 illustrates a carrying device 9 which comprises a tubular (preferably cylindrical) shell 26 for a cylindrical mass 27 of filler material. Such filler material can consist of or contain peat, planting soil, organic fibers and/or mixtures of such substances. Actually the filler material 27 can consist of or contain any substance in which a seed 28 can germinate and/or a plant cutting (not shown in Figure 2) can grow roots. The material of the shell 26 is preferably paper or any other material which can disintegrate after a short period of dwell in soil. Paper is but one of the materials which can be used for the making of shells 26. For example, such shells can be made of a suitable synthetic plastic material

which may or may not disintegrate within a short period of time subsequent to introduction into a mass of soil, depending upon whether or not rapid destruction of the envelope for the mass 27 of filler material is actually desirable or necessary.

The details of the suction head 13, as well as of the drive means 17 therefor, and of the means for attracting carrying devices 9 to its flutes 12 are illustrated in Figures 3, 4 and 5. The drive 17 and the means for transmitting motion therefrom to the suction head 13 are designed in such a way that the suction head is movable up and down in order to move a row 10 of carrying devices 9 in its flutes 12 between the planes A and U without changing its inclination relative to the upper reach of the conveyor 11. The drive 17 comprises a pneumatic cylinder and piston unit 31 having a piston rod 32 which can pivot two bell crank levers 34 through the medium of a coupling pin 33. The cylinder of the unit 31 is articulately connected to the frame G of the improved apparatus. The bell crank levers 34 are pivotable in the frame G at 36 and their lower arms are connected to the piston rod 32 by the aforementioned pin 33. The upper arms 58, 59 of the two bell crank levers 34 are connected to the adjacent end portion of the suction head 13 by means of a horizontal sleeve 37 which is rigid with the arms 58,59 and is turnable in a bore at the front end of the suction head 13 when the piston rod 32 performs a forward or return stroke counter to or in the direction indicated by the arrow 63. The internal space 38 of the sleeve 37 is connected to the suction chamber 16 of the suction head 13 by a slot 41. An opening 42 in the sleeve 37 can be moved into or out of register with an opening 43 in the front end portion of the suction head 13. The opening 43 is a venting orifice for rapidly increasing the pressure in the suction chamber 16 and ports 14 to atmospheric pressure. The sleeve 37 is connected by a conduit (not shown) with a suction generating device, such as the intake of a suction fan, to insure the pressure in the suction chamber 16 will remain below atmospheric pressure as long as this chamber is permitted to communicate with the interior 38 of the sleeve 37 by way of the opening 41. The connection between the suction chamber 16 and the interior of the sleeve 37 further comprises a channel 39 which is machined into the front portion of the suction head 13. The arrangement is such that the opening 41 invariably establishes communication between the internal space 38 of the sleeve 37 and the channel 39 in each angular position of the sleeve 37 with reference to the suction head. As mentioned before, the sleeve 37 is rigidly connected to the upper arms 58,59 of the bell crank levers 34 so that it turns relative to the suction head 13 when the piston rod 32 performs a forward or return stroke.

The underside of the upper reach of the belt conveyor 11 travels along the upper side of a supporting plate 44 (see particularly Figure 5) which is disposed between two elongated frame members 46 and 47. The pulleys 48 and 49 for the belt conveyor 11 are rotatably mounted in the frame members 46 and 47. That end (51) of the suction head 13 which is remote from the sleeve 37 is mounted in two links 52 and 53 which are provided with slots for a transversely extending shaft 54 of the suction head so that the latter can be readily detached from the links 52 and 53. The lower portions of the links 52 and 53 are connected to the respective frame members 46, 47 by stubs 56, 57 (see Figure 5). The links 52, 53 and the upper arms 58, 59 of the two bell crank levers 34 constitute a parallel motion mechanism for guidance of the suction head 13 in the aforedescribed manner, namely so that the plane of the row of flutes 12 remains parallel with the upper reach of the conveyor 11 irrespective of the angular positions of the bell crank levers 34. The reference character 61 denotes a passage or channel wherein air flows into the flutes 12 and thence into the respective suction ports 14 when the suction head 13 is in the process of accumulating a row 10 carrying devices 9. Such channel is flanked from above by the upper side of the suction head 13 and from below by the frame members 46, 47, the supporting plate 44 and the upper reach of the conveyor 11. The flow of air is induced by the suction chamber 16 in the suction head 13.

The operation of the suction head 13 is as follows:

The belt conveyor 11 advances a single layer of carrying devices 9 at regular or irregular intervals in such a way that the axes of the devices 9 extend at right angles to the direction which is indicated in Figure 4 by the arrow A. When the gathering of the first row 10 of carrying devices 9 is started, all of the flutes 12 at the underside of the suction head 13 are empty so that the suction in the foremost flute 12 (namely in the leftmost flute of Figure 4) is more pronounced than in all other flutes of the suction head 13. Consequently the foremost carrying device 9 of the layer on the upper reach of the conveyor 11 advances below the remaining flutes 12 and is lifted by suction into the foremost flute under the action of the suction chamber 16 which then communicates with the suction generating device by way of the channel 39 and the internal space 38 of the sleeve 37. When the foremost flute 12 is filled (whereby the corresponding suction port 14 ceases to draw air from the aforementioned passage or channel 61), the pressure in the adjacent (next-following) flute 12 is lower than in all of the remaining unfilled flutes. Therefore, the next carrying device 9 advances into the range of and is automatically lifted by suction into such second flute 12 of the suction head 13. The same procedure is repeated again and again until each and every flute 12 contains a rod-shaped carrying device 9, i.e., until the formation of a complete row 10 is completed. Figure 4 shows that the four foremost flutes 12 are already occupied whereby the suction chamber 16 draws a stream of air (see the arrow 62) primarily into the fifth flute 12 of the suction head 13. Consequently, the oncoming foremost carrying device 9 continues to advance along the upper reach of the conveyor 11 and thereupon leaves such conveyor to enter the fifth flute 12 from below and to thereby automatically enable the sixth flute 12 to attract the next-following device 9. A device 9 which is about to enter the allotted flute 12 travels rapidly (sideways) with the

upper reach of the conveyor 11 and thereupon abruptly leaves such upper reach to rise into the foremost empty flute 12 under the action of suction which prevails in the chamber 16 and in the corresponding port or ports 14. Such mode of operation of the suction head 13 ensures that the formation of a full row 10 is completed within very short intervals of time.

When the formation of a row 10 is completed, the cylinder of the pneumatic motor 31 retracts the piston rod 32 in a direction to the right, as viewed in Figure 4, so that the bell crank levers 34 are pivoted in a counterclockwise direction as indicated by the arrow 63. This results in a lifting of the suction head 13 so that the freshly accumulated row 10 is transferred from the plane arrow A into the plane U shown in Figure 1. As mentioned above, the row 10 of carrying devices 9 in the flutes 12 of the suction head 13 remains parallel to the upper reach of the conveyor 11 during movement of the suction head from the lower to the raised position.

In the next step, the drive 18 actuates the pusher 19 so that the latter performs a forward stroke (in a direction to the right, as viewed in Figure 1) and expels the carrying devices 9 of the lifted row 10 from the flutes 12 through the mouthpiece 21 and into the empty or partly empty tray 2 at the filling station 8. In the next step, the drive 18 retracts the pusher 19 as rapidly as possible and the motor 31 pivots the bell crank levers 34 in a clockwise direction back to the angular positions of Figure 4 whereby the suction head 13 is returned to its lower position and its flutes 12 are ready to accumulate a fresh row of carrying devices 9. As mentioned above, the conveyor 11 continues to advance the carrying devices 9 in the direction of arrow A while the suction head 13 is held in the raised position so that the foremost device 9 on the conveyor 11 approaches the foremost flute 12 and is ready to be lifted into such flute as soon as the suction head 13 returns to the position of Figure 4. The accumulation of a fresh row 10 is then carried out in the aforedescribed manner and in a fully automatic way because the suction in successive flutes 12 becomes more pronounced in response to occupation of the preceding flutes, namely in response to lifting of carrying devices 9 into such preceding flutes.

The lifting of the suction head 13 from the position of Figure 4 to the position in which the freshly formed row 10 is located in the plane U preferably takes place in automatic response to filling of the last flute 12. This can be readily accomplished by monitoring the pressure in the suction chamber 16, in the channel 39 and /or in the internal space 38 of the sleeve 37. Such pressure changes abruptly when the last flute 12 is filled whereby a pressure-responsive switch actuates the drive 17 in a sense to lift the suction head 13 to the position in which the row 10 of carrying devices 9 in its flutes 12 is in register with the front end face of the still retracted pusher 19. Such lifting of the suction head 13 can be monitored by a proximity switch or an analogous device which then actuates the drive 18 for the purpose of inducing the pusher 19 to transfer the freshly lifted row 10 of devices 9 into the adjacent tray 2 at the filling station 8. Figures 7 and 8 illustrate one mode of storing and arraying successive rows 10 of carrying devices 9 in the interior of a tray 2 which is then held in upright position (with its bottom wall in a vertical plane) during stepwise downward movement in the plane F of Figure 1.

When the suction head 13 is lifted by the bell crank levers 34, the opening 42 of the sleeve 37 moves into register with the opening 43 so that the pressure in the suction chamber 16 increases because the opening 43 is free to communicate with the atmosphere. The dimensions of the openings 42 and 43 (or the extent to which the opening 42 then registers with the opening 43) can be selected in such a way that the pressure in the suction chamber 16 rises to atmospheric at a time or shortly after the pusher 19 begins to perform a forward stroke and the leading ends of the devices 9 forming the row 10 in the flutes 12 of the raised suction head 13 are already received in the mouthpiece 21 so that they cannot descend in response to termination of suction in the ports 14 of the suction head 13. The provision of openings 42, 43 is optional because the apparatus can also operate in such a way that the pusher 19 expels the row 10 of devices 9 from the flutes 12 while the corresponding ports 14 continue to attract the shells 26 of the respective devices 9 with full force. This depends, to a certain extent, on the ability of the material of the shells 26 to resist suction which is applied by the ports 14 while the respective devices 9 must slide relative to the suction head 13 toward the interior of the tray 2 at the filling station 8.

Figure 6 shows a modified carrying device 9' which comprises a cylindrical shell 26' and a cylindrical mass 27' of filler material. The material in the shell 26' does not contain one or more seeds 28. Instead, one end face 30 of such filler material 27' is provided with a preferably centrally located elongated recess 29 in the form of a blind hole which is designed to receive one or more seeds or a portion of a cutting, not shown.

The manner of manipulating rod-shaped carrying devices 9' of the type shown in Figure 6 is the same as the manner of manipulating the devices 9. The pusher 19 or an analogous transfer member preferably acts against the end faces 30 of the carrying devices 9' so that the recesses 29 are accessible subsequent to introduction of such devices into a tray 2.

Figures 7 and 8 illustrates portion of a container or tray 2a which is not provided with the reinforcing ribs 2' shown on the containers 2 of Figure 1. The reinforcing ribs 2' are provided on the external surfaces of the respective trays 2 and serve to ensure that the trays 2 are not distorted subsequent to complete filling with a requisite number of rows of rod-shaped carrying devices 9 or 9'. The interior of the tray 2a of Figures 7 and 8 is provided with a plurality of square or rectangular cells or compartments 88 at one side of its bottom wall 82. As mentioned above, such bottom wall is located in a vertical plane during travel of the respective tray in the vertical plane F of Figure 1. The compartments or cells 88 are formed by parallel horizontal partitions or walls 83 and parallel vertical partitions or walls 84

which intersect the horizontal partitions 83. An important function of the partitions 83 and 84 is to ensure that each and every introduced carrying device 9 or 9' remains in its alloted space (namely in the corresponding cell or compartment 88) as well as to prevent the roots of growing plants or germinating seeds in such devices from migrating from one cell to the next cell or cells. The bottom wall 82 of the tray 2a shown in Figures 7 and 8 has openings 87 which register with the corresponding compartments or cells 88 and can be used to facilitate expulsion of carrying devices 9 or 9' from such cells. The illustrated openings 87 have a circular shape; however, it is also possible to provide the bottom wall 82 with otherwise configurated (for example, polygonal) openings, depending on the dimensions and/or configuration of tools which are used to effect expulsion of carrying devices from the respective cells. Such tools can constitute reciprocable pushers which are not shown in the drawing. The area of each opening 87 is less than the cross-sectional area of the respective cell 88 so that each carrying device 9 or 9' can rest on a portion 86 of the bottom wall 82 when the bottom wall is moved to a horizontal position below the adjacent end faces of the devices 9 or 9' therein.

Figures 9 and 10 illustrate a modified container or tray 2b wherein the partitions 83 and 84 have centrally located projections or ribs 89 serving to center the carrying devices 9 or 9' in the respective compartments or cells 88. The provision of ribs 89 ensures that each of the devices 9 or 9' is rather snugly received in the respective cell and cannot wobble and thereby move nearer to or further away from the neighboring devices during manipulation (particularly during changes in orientation) of the respective tray 2b. The cross-sectional area of each cell 88 in the tray 2a of Figures 9 and 10 can be larger or much larger than the cross-sectional area of a compartment or cell 88 in the tray 2a of Figures 7 and 8.

Figures 11, 12 and 13 illustrate a further container or tray 2c which can be utilized in the apparatus of Figures 1. This tray has relatively low sidewalls 91 with higher column-like corner portions 92 for the purpose of stacking of superimposed trays in such a way that the carrying devices 9 or 9' in such trays will not be damaged as a result of superimposition of two or more trays on top of each other. The bottom wall 94 of the tray 2c need not always be provided with partitions because such bottom wall carries an array of pointed holding and retaining tools 93 in the form of sharp needles or pins each of which can impale one of the carrying devices 9 or 9' by penetrating into that end face of the respective filler material 27 or 27' which is adjacent to the bottom wall 94 of the tray 2c upon completed transfer of a row of such devices. The manner in which the tools 93 are introduced into or made integral with the bottom wall 94 of the tray 2c of Figures 11 to 13 forms no part of the present invention. As shown in Figures 12 and 13, the bottom wall 94 of the tray 2c can still be provided with rather shallow cells or compartments 96 whose purpose is to gather moisture and/or fertilizer for the plants in the respective carrying devices 9 or 9'. The tray 2c can be made from inexpensive fibrous material, for example, a material of the type often used for the making of egg cartons.

Figure 14 illustrates a modified apparatus which utilizes trays 2c of the type shown in Figures 11 to 13. The reference character 102 indicates a continuous rod of coherent carrying devices 109 which are severed from the leading end of the rod 102 by an orbiting knife 104 and each of which can be identical with the carrying device 9 of Figure 2. The direction in which the rod 102 is advanced is indicated by the arrow 101, and the arrow 103 indicates the direction of orbital movement of the knife 104. Successive carrying devices 109 are propelled into the space between two rotating eccentric accelerating members 106a, 106b which rotate in directions respectively indicated by the arrows 107a, 107b. The purpose of the members 106a, 106b is to accelerate successive carrying devices 9 so as to separate the accelerated devices from the next-following devices. Such accelerated and spaced-apart carrying devices are thereupon entrained by a belt conveyor 112 which is trained over pulleys 111a, 111b rotating in directions indicated by the arrow 108. The upper reach of the conveyor 112 transports a single file of coaxial carrying devices 109 to a deflecting station where successive foremost devices 9 are caused to move sideways, namely in a direction at right angles to their respective axes. The deflecting unit 113 comprises a paddle 114 which is secured to a lever 116. The lever 116 has an elongated slot 117 for a stationary guide pin 118 and is connected to an eccentric disc 122 by a pin 119. The disc 122 is driven to rotate in the direction of arrow 121.

The deflecting unit 113 directs successive deflected carrying devices 109 into the receiving means (preferably flutes) 123 of a supply conveyor in the form of an endless chain 124. The flutes 123 can be provided in the cradles 126 of the chain links 127 in a manner as shown on a larger scale in Figure 15. The mutual spacing of successive flutes 123 corresponds to that between the neighboring pin-shaped impaling tools 93 in the trays 2c of the type shown in Figures 11 to 13. If the trays 2c are replaced with trays 2, 2a or 2b, the mutual spacing of flutes 123 peferably matches the spacing between the centers of neighboring cells or compartments 88 shown in Figures 7 to 10.

The chain conveyor 124 is trained over sprocket wheels 128, 128b (see particularly Figure 16) and its upper reach advances in the direction which is indicated by the arrow 129 shown in Figure 14.

A machine which can produce the rod 102 is disclosed in commonly owned copending patent application Serial No. filed May, 1984 by Johannes Mielke.

The row gathering means of the apparatus shown in Figure 14 comprises a suction head 131 which is mounted on the gear box 132 of a filling device 133 and the details of which are illustrated in Figures 16, 17, 18, 19 and 20. The arrangement is such that the suction head 131 simultaneously lifts a full row of carrying devices 109 from the flutes 123 on the upper reach of the chain conveyor 124 in a row forming

plane A which is indicated in Figure 16. In the next step, the freshly lifted row of carrying devices is raised from the gathering plane A into a transfer plane U in front of a transfer member in the form of a pusher 134 best shown in Figure 20.

The transfer member 134 is mounted on a bracket 136 of the filling device 133 and is reciprocable in directions indicated by the double-headed arrow 137 toward and away from a tray 2c at the filling station. When the transfer member 134 moves toward the tray 2c, it pushes a row of carrying devices 109 from the suction head 131 and causes the devices 109 of such row to be impaled on the registering tools 93 on the bottom wall of the tray.

The trays 2c are removed, either by hand or by means of a suitable machine, from a stack 138 shown by phantom lines in the lower right-hand portion of Figure 14 and are placed onto a lower or supply conveyor 139 for the purpose of changing the orientation of successive empty trays 2c. The orientation changing means is denoted in Figure 25 by the reference character 141. Figure 24 shows a tray lifting or raising unit 142 which accepts successive trays 2c, one after the other, from the orientation changing means 141 and advances such trays stepwise upwardly past the filling device 133 toward and into the range of a second orientation changing means 143 which is illustrated in Figure 25 and serves to change the orientation of filled trays 2c and deposit the thus reoriented filled trays on a further conveyor 144 which serves as a means for removing filled trays from the apparatus of Figure 14. The conveyor 144 can deliver filled trays 2c to a stacking station 146.

The chain conveyor 124, the suction head 131 and the lifting unit 142 are preferably driven by the main prime mover of the machine which produces the aforediscussed rod 102 of coherent carrying devices 109. This machine may resemble a conventional filter rod making or cigarette rod making machine. Such machines are manufactured by the assignee of the present application. The main prime mover of the machine which produces the rod 102 drives an output shaft 147 which rotates in the direction of arrow 148 shown in the upper left-hand portion of Figure 14 and which drives the moving parts of the apparatus of Figure 14 through the medium of an endless toothed belt or chain conveyor 149, a transmission 151 and a further endless chain or toothed belt conveyor 150.

The details of the suction head 131 are illustrated in Figures 16 and 17. This suction head comprises an elongated housing 152 defining a suction chamber 153 which is connected to a suitable suction generating device by a flexible conduit 154. The underside of the housing 152 faces the upper reach of the chain conveyor 124 and is provided with receiving means in the form of relatively shallow flutes 156 the mutual spacing of which corresponds to that of the flutes 123 on the chain conveyor 124 as well as to the mutual spacing of neighboring impaling tools 93 in the trays 2c. The flutes 156 communicate with the suction chamber 153 by way of suction ports 157.

The housing 152 is eccentrically mounted on two crank discs 159a, 159b by way of arms 158a, 158b. Such crank discs constitute or form part of a means for lifting and lowering the suction head 131 and are mounted in the gear box 132 shown in Figure 14. A stepping drive (for example, a reel star transmission) is provided to drive the crank discs 159a, 159b at intervals so that such discs always perform a complete revolution with a period of idleness when the crank pins 161a, 161b of such discs reach their upper dead center positions (Figures 19 and 20).

The mode of operation of the suction head 131 will be readily understood by referring to Figures 16, 18 and 19. Figure 16 shows the suction head 131 during the initial stage of its orbital movement along an endless path at the level above the upper reach of the chain conveyor 124. At such time, the suction head 131 has a component of movement first counter and then in the direction of arrow 129 so that its flutes 156 travel at or close to the speed of carrying devices 109 on the chain conveyor 124 therebelow. The flutes 156 then communicate with the suction chamber 153 in the interior of the housing 152 so that the suction head 131 simultaneously lifts a predetermined number (a complete row) of carrying devices 109 from the chain conveyor 124. Figure 16 shows the suction head 131 still in or close to the raised position. After moving through an angle of 180°, the discs 159a, 159b cause the housing 152 of the suction head 131 to assume the position which is shown in Figure 18 whereby the flutes 156 are immediately adjacent to the upper reach of the conveyor 124 and attract the adjacent carrying devices 109 for the purpose of ensuring the transfer of such devices onto the suction head 131. Figure 19 illustrates the suction head 131 in the fully lifted position and in a state of idleness preparatory to transfer of the freshly lifted row of carrying devices 109 into the adjacent tray 2c.

The transfer member 134 which is mounted on the aforementioned bracket 136 then takes over in a manner as illustrated in Figure 20. Thus, the transfer member receives motion from a crank drive 162 including an electric motor 163 which drives a disc cam 164 having a crank pin 166 for a connecting rod or link 168 carrying at its rear end an upwardly extending motion transmitting pin 167. The pin 167 is coupled to the transfer member 134. The member 134 contains or carries a further pusher 169 which resembles a comb and is movable relative to the transfer member 134 in directions indicated by a double-headed arrow 171. The prongs 172 of the comblike pusher 169 constitute pointed pins or mandrels which can be made integral with the pusher 169, for example by resorting to an injecting molding technique. The mutual spacing of mandrels 172 on the pusher 169 corresponds to that between the centers of neighboring flutes 156 at the underside of the suction head 131 and also to the mutual spacing of pointed impaling tools 93 in the tray 2c. The mandrels 172 of the comb-like pusher 169 serve to penetrate into the adjacent end faces of cylindrical filler materials in the carrying devices 109 and to form therein recesses corresponding to the recess 29 in the filler material 27' of the carrying device 9' shown in Figure 6. As explained above, the purpose of such recesses is to receive one or more seeds 28

or portions of cuttings, not shown.

A tension spring 173 is provided in the transfer member 134 to normally maintain the pusher 169 in a retracted position. A pin 174 of the pusher 169 carries a roller follower 176 which tracks the periphery of the rotating disc cam 164 and can be shifted by a lobe 177 of such cam so as to overcome the resistance of the spring 173 and move the pusher 169 forwardly toward the suction head 131. The arrangement is such that the lobe 177 engages the roller follower 176 and shifts the pusher 169 forwardly when the transfer member 134 has completed its forward stroke and has transferred a fresh row of carrying devices 109 into the adjacent tray 2c. This causes the mandrels 172 of the pusher 169 to penetrate into the adjacent end faces of the carrying devices 109 while such devices are already impaled on the registering tools 93 of the tray 2c. As soon as the lobe 177 advances beyond the roller follower 176, the spring 173 is free to contract and to return the pusher 169 to the position shown in Figure 20, namely to a position in which the mandrels 172 are remote from the front end faces of the adjacent carrying devices 109 in the tray 2c.

The control means for the electric motor 163 can comprise, for example, two limit switches (not shown) one of which serves to start the motor 163 when the suction head 131 reaches its upper end position shown in Figure 19. The other limit switch serves to arrest the electric motor 163 when the transfer member 134 is retracted to its rear end position. Such limit switches can constitute proximity switches which are actuated, respectively, by the housing 152 of the suction head 131 and by a portion of the transfer member 134.

Figures 21 to 23 illustrate the transfer of a carrying device 109 from its flute 156 at the underside of the housing 152 of the suction head 131 onto a pointed impaling tool 93 in the adjacent tray 2c.

Each forward movement of the transfer member 134 results in the transfer of a predetermined number (namely a full row) of carrying devices 109 from the suction head 131 into the adjacent ray 2c, namely onto the adjacent row of impaling tools 93. In the next step, the transfer member 134 is retracted and the tray 2c is lifted by a step so as to place the next row of impaling tools 93 into register with the flutes 156 at the underside of the housing 152 of the suction head 131 as soon as such suction head again assumes the raised position of Figure 19. Referring to Figure 24, there is shown the aforementioned lifting unit 142 for stepwise raising of trays 2c at the filling station adjacent to the suction head 131. This lifting unit 142 comprises two endless chain conveyors 183a, 183b which are respectively trained over sprocket wheels 181a, 182a and 181b, 182b. The chain conveyors 183a, 183b respectively carry bracket-like L-shaped platforms 184a, 184b which serve as supports for the trays 2c. The platforms 184a, 184b are respectively provided with actuating elements or trips 186a, 186b. The sprocket wheels 181a and 182a are driven in directions indicated by arrows 187a, 187b through such angular distances that each incremental advance involves lifting of the trays 2c on the conveyors 183a, 183b through a predetermined distance which is necessary to place successive rows of impaling tools 93 into register with the flutes 156 of the suction head 131 when the latter is moved to its raised position shown in Figure 19.

As can be seen in Figure 24, successive trays 2c on the lifting unit 142 are spaced apart from each other. This necessitates a stepwise advance of the chains 183a, 183b through a greater distance when a tray 2c has been filled with the next row of carrying devices 109 is to be transferred onto the uppermost row of impaling tools 93 in the empty tray 2c. Alternatively, the conveyors 183a, 183b can be caused to perform a series of successive steps in rapid sequence as soon as the filling of a tray 2c is completed. The number of such steps is selected with a view to ensure that the chain conveyors 183a, 183b come to a halt when the uppermost row of impaling tools 93 in an empty tray 2c is in register with the flutes 156 of the suction head 131.

Figure 25 shows the supply conveyor 139, the removing conveyor 144, the two orientation changing means 141, 143 and certain other components of the apparatus of Figure 14. The supply conveyor 139 is trained over pulleys 188 (only one shown) and includes two discrete endless belts or bands 189a, 189b which are driven to advance stepwise in directions indicated by the arrows 191a, 191b. The removing conveyor 144 also comprises two endless bands or belts 193a, 193b which are trained over pulleys 192, 192b and are driven to advance in directions indicated by the arrows 194a, 194b.

The orientation changing means 141 comprises a substantially U-shaped carriage 197 which is pivotable about the axis of a shaft 196 and has a relatively long rear wall 198 and a relatively short front wall 199. A drive which is not shown (for example, a linkage which is driven by a cam) pivots the carriage 197 from the position 197' which is indicated by phantom lines (and in which the rear wall 198 is disposed between the belt conveyors 189a and 189b so that a tray 2c can be advanced into the carriage 197) and a second position 197" which is also indicated by phantom lines and which is a waiting or rest position of the carriage. When the carriage 197 contains an empty tray 2c, it is pivoted from the position 197" to the position which is illustrated by solid lines as soon as a tray 2c is raised to the requisite level by the lifting unit 142 of Figure 24. The thus lifted tray 2c is then engaged by the platforms 184a, 184b of the chain conveyors 183a, 183b and is lifted out of the carriage 197. As soon as such tray 2c has been lifted over the front wall 199, the carriage 197 is pivoted back to the position 197'. The various pivotal movements of the carriage 197 are initiated by the aforementioned trips 186a on the platforms 184a of the chain conveyor 183a. To this end, such trips cooperate with suitably located switches which are not specifically shown in Figure 25.

The orientation changing means 143 comprises a holder 202 for filled trays 2c. Such holder is mounted on disc-shaped carriers 201a, 201b and is pivotable about the axis of a shaft 203 by a non-illustrated drive from the solid-line position to a phantom-line position 202' and thereupon back to the solid-line position. In the phantom-line position 202' of the

holder 202, a tray 2c is engaged by the belt conveyors 193a, 193b and is transported away. In order to achieve this, a rear wall of the holder 202 constitutes a U-shaped frame 204. The frame 204 is flanked by laterally disposed U-shaped guides 206a, 206b into which is pushed a tray 2c when the holder 202 assumes its solid-line position. The transfer of such tray into the holder 202 is effected by the lifting unit 142 of Figure 24 whereby the tray is engaged at both sides to be pivoted toward the belt conveyors 193a and 193b. The tray 2c is held in the holder 202 by a supporting bracket 208 which is mounted on a shaft 207 and can be pivoted by a lever 209 which is secured to the shaft 207. Pivoting of the lever 209 is effected by the trips 186b of the platforms 184b on the chain conveyor 183b. Such actuation takes place when a platform 184b with a tray 2c thereon reaches a selected level. The pivotal movement of the bracket 208 back to its starting position with reference to the holder 202 takes place during pivotal movement of the holder 202 back to its solid-line position. The lever 209 is then actuated by a trip which is fixedly secured to the frame on the machine and is not specifically shown in the drawing.

An important advantage of the improved method and apparatus is that they render it possible to handle large numbers of carrying devices 9, 9' or 109 per unit of time. This is attributable, to a certain extent, to the fact that all carrying devices of a freshly formed row are introduced into the adjacent container in a single step, are contrasted to introduction of discrete carrying devices, one at a time.

Another important advantage of the improved method and apparatus is that the carrying devices preferably are and remain equidistant from one another not later than when they are gathered into rows as well as during introduction of such rows into containers and during dwell in the interior of the respective containers. The allotment of discrete compartments, cells or impaling tools for the carrying devices in the containers is desirable and advantageous because this ensures that the roots of neighboring plants, which are permitted to grow in filled containers, will not become entangled to thus interfere with convenient removal of adequately grown plants for the purpose of planting in a garden, in a nursery or in the field. Moreover, the provision of spaces between neighboring carrying devices in the containers facilitates manual or mechanical withdrawal of such devices for the purpose of implanting in soil.

A further important advantage of the improved method and apparatus is that the carrying devices can be processed at the rate they are turned out by a high-speed producing machine, e.g., a machine which turns out the continuous rod 102 shown in Figure 14. The provision of means for lifting successive carrying devices seriatim (as shown in Figure 4) or in the form of complete rows (as shown in Figure 19) ensures that the delivery of oncoming carrying devices 9, 9' or 109 need not be interrupted for the purpose of accumulating such devices into a succession of rows. As explained above, the lifting takes place through a distance (between the planes A and U) which suffices to ensure that the foremost carrying devices on the conveyor 11 or 124 can continue to advance along their path at all times because the suction head 13 or 131 does not interfere with such movements of the carrying devices toward the locations where they enter the flutes 12 or 156. Such mode of manipulating the suction head renders it possible to gather successive rows of predetermined numbers of articles at a surprisingly high frequency and with a high degree of accuracy which is important for the aforediscussed reasons including the advisability of introducing each carrying device into a predetermined portion of the respective container. Moreover, and while mechanical arresting of carrying devices on the conveyor 11 or 124 is not excluded, absence of such mechanical stoppage is evidently advantageous, especially when the carrying devices are supplied at an elevated speed so that abrupt stoppage of the foremost carrying device of a layer of such devices on the conveyor 11 or 124 could cause damage to the foremost devices as well as to the next-following devices. Nevertheless, it is possible to resort to apparatus wherein a stop is caused to descend or rise into the path of movement of the supplying conveyor (especially on the upper reach of the conveyor 11 which does not have discrete flutes, cradles or like receiving means for the carrying devices 9 or 9') whenever the gathering of a complete row of carrying devices is completed and a certain interruption of the delivery of fresh devices is necessary in order to move the freshly gathered row out of the way.

Each of the illustrated apparatus exhibits the advantage that the formation of rows which do not contain predetermined numbers of carrying devices is highly unlikely. This is due to the fact that the suction head 13 of Figures 3 to 5 can form rows of equidistant carrying devices 9 irrespective of the mutual spacing of such devices on the upper reach of the conveyor 11, and that the chain conveyor 124 of Figure 14 receives a carrying device 109 in each of its flutes 123 so that the suction head 131 can invariably lift complete rows each of which contains the same number of carrying devices. This is desirable and advantageous for obvious reasons, especially because it ensures that each and every one of a short or long series of containers 2, 2a, 2b or 2c can be filled to capacity.

The operation of the improved apparatus can be automated to any desired extent by resorting to various monitoring devices in the form of photocells, limit switches, proximity switches mechanical sensors and/or others so as to ensure that successive operations are carried out in a predetermined sequence and in immediate response to completion of the preceding operation. This applies not only for the lifting and/or other movements of the suction head but also for lowering or raising of the containers at the filling station, for admission of one or more empty containers into the filling station during filling of the preceding container and automatic removal and processing of filled containers. Not only the apparatus of Figure 14 but the apparatus of Figure 1 is capable of placing an empty container into the plane of the filling station long before the preceding

container receives the last row of carrying devices so that the transfer of successive rows of carrying devices need not be interrupted at all or is interrupted for a negligible interval of time in order to allow for the placing of the uppermost or lowermost row of compartments or impaling tools in an empty container into register with the transfer member 19 or 134.

The utilization of supply conveyors and removing conveyors which can store requisite numbers of empty and filled containers contributes to compartness of the apparatus and further reduces the likelihood of longer interruptions between the filling of successive containers.

The provision of orientation changing means for empty or filled containers is desirable and advantageous for space considerations, in order to ensure that the carrying devices in filled trays will be stored in upright position and also to reduce the likelihood of deformation of or damage to containers during transport along their path toward, past and beyond the filling station. As a rule, the containers will constitute thin-walled flat trays in order to save space and material. Such relatively thin and hence relatively unstable containers must be handled with care in order to avoid damage prior to, during and especially after filling. It has been found that an empty or filled container is least likely to be damaged or deformed if it is transported in a horizontal (prone) position. On the other hand, stepwise advancement of containers at the filling station, while their bottom walls are disposed in a vertical plane, is advantageous for convenient introduction of horizontal rows of parallel equidistant carrying devices. This can be readily achieved with the transporting means of Figures 24 and 25. It will be noted that, whereas the filled containers of Figure 1 move in the axial direction of the carrying devices 9 therein (note the arrow 23), the filled containers 2c of Figure 25 move in a direction at right angles to the axes of the carrying devices 109 therein.

CLAIMS

1. A method of storing pluralities of substantially rod-like carrying devices for incipient plants in successive containers wherein the plants can be or are caused to grow, comprising the steps of advancing a series of devices transversely along a predetermined path; gathering successive groups of the thus advanced devices into a succession of rows of parallel equidistant devices; and introducting the devices of such rows into containers, including moving the devices longitudinally.

2. The method of claim 1, wherein said introducing step further includes simultaneously inserting all of the devices of a full row into the respective container.

3. The method of claim 1, further comprising the step of maintaining the introduced devices in the respective containers in spaced-apart positions.

4. The method of claim 1, further comprising the step of establishing in each container a discrete compartment for each of the devices therein.

5. The method of claim 1, further comprising the step of impaling each introduced device in the respective container to thereby fix the impaled device in predetermined position.

6. The method of claim 1 of storing rod-like devices of the type having a peripheral surface and two end faces, wherein one end face of each introduced device remains exposed and further comprising the step of forming a recess in the one end face of each device not later than upon introduction into the respective container.

7. The method of claim 6, wherein said forming step takes place simultaneously with introduction of devices into the respective containers.

8. The method of claim 6, further comprising the step of inserting incipient plants into said recesses.

9. The method of claim 1, wherein said advancing step comprises continuously conveying the devices of said series along said predetermined path and said gathering step includes accumulating the oncoming foremost devices of said series into said succession of rows in a predetermined portion of said path and removing each freshly accumulated row from said path so as to enable the oncoming devices to enter said portion of the path for accumulation of the next-following row.

10. The method of claim 9, wherein said portion of said path is substantially horizontal and is disposed at a predetermined level, said removing step including shifting each freshly accumulated row to a level other than said predetermined level.

11. The method of claim 1, wherein said advancing step includes conveying a single layer of parallel devices along said path and said gathering step includes pneumatically lifting successive foremost devices from said path into a second path and holding successive lifted devices next to one another until the accumulation of the respective row is completed.

12. The method of claim 11, wherein said lifting step includes raising the devices by suction and said holding step includes maintaining the lifted devices next to one another by suction in discrete flutes of a row forming unit.

13. The method of claim 1, wherein said advancing step comprises conveying a single layer of equidistant devices along said path and said gathering step includes transferring rows containing predetermined numbers of devices from the leading end of the layer in said path into a second path while the mutual spacing of the transferred devices remains unchanged, said introducing step including advancing successive rows of devices along said second path and into the respective containers while leaving the mutual spacing of the devices in such rows unchanged and further comprising the step of holding the devices of said rows in the respective containers without changing the mutual spacing of the devices in such rows.

14. The method of claim 1, wherein said rows are at least substantially horizontal and the containers are arranged to receive arrays consisting of several superimposed rows of devices, and further comprising the step of moving the container which is in the process of receiving an array of rows in stepwise fashion so as to provide room for introduction of

successive rows.

15. The method of claim 1, wherein said introducing step includes moving the container which is in the process of receiving rows of devices in stepwise fashion transversely of the longitudinal directions of the devices in said rows, and moving the filled container in the longitudinal direction of the devices therein.

16. The method of claim 1, further comprising the step of moving the container which is in the process of receiving rows of devices in a vertical plane and in stepwise fashion during the intervals between admissions of successive rows.

17. The method of claim 1, further comprising the step of changing the orientation of successive filled containers.

18. The method of claim 17, wherein said orientation changing step includes tilting each filled container from a substantially upright position in which the devices therein are at least substantially horizontal to a substantially prone position in which the devices therein are at least substantially vertical.

19. The method of claim 1, further comprising the step of transporting a succession of containers along a predetermined second path including advancing empty containers in prone position and advancing the containers which are in the process of being filled with rows in upright position.

20. Apparatus for storing pluralities of substantially rod-like carrying devices for incipient plants in containers wherein the plants can be or are caused to grow, comprising conveyor means for advancing a series of devices along a predetermined path wherein the devices move transversely of their longitudinal directions; means for converting successive conveyed devices into rows each of which contains a predetermined number of equidistant parallel devices; and means for transferring pluralities of successively formed rows into successive containers, including means for moving the rows in the longitudinal direction of the respective devices.

21. The apparatus of claim 20, wherein said transferring means includes means for simultaneously introducing all devices of a complete row into the respective container.

22. The apparatus of claim 20 for storing carrying devices of the type having two end faces, wherein said transferring means includes means for forming a recess in one end face of each device during transfer of the respective row into a container.

23. The apparatus of claim 22, wherein said transferring means includes a reciprocable transfer member arranged to transfer a complete row of devices into a container and said recess forming means includes a plurality of tools movable with and relative to said transfer member and each arranged to penetrate into the one end face of a discrete device during transfer of the respective row.

24. The apparatus of claim 20, wherein said converting means comprises means for gathering predetermined numbers of devices into rows adjacent to a predetermined portion of said path and means for moving said gathering means relative to said portion of said path so that the freshly accumulated row does not interfere with introduction of fresh devices into said portion of said path.

25. The apparatus of claim 24, wherein said moving means includes means for shifting the devices of full rows transversely of such devices through a distance which at least equals the diameter of a device.

26. The apparatus of claim 24, wherein said gathering means comprises a suction head having an underside provided with a row of receptacles, one for each device of a row, and means for attracting devices from said portion of said path into said receptacles by suction.

27. The apparatus of claim 26 for storing devices in containers of the type having equidistant portions allotted for reception of discrete devices, wherein the mutual spacing of such equidistant portions matches the mutual spacing of neighboring receptacles at the underside of said suction head.

28. The apparatus of claim 26, wherein said suction head has an elongated suction chamber and ports communicatively connecting said chamber with said receptacles.

29. The apparatus of claim 20, wherein said conveyor means includes equidistant receiving means for discrete devices and said converting means comprises means for removing from said path complete rows of equidistant devices.

30. The apparatus of claim 29 for storing devices in containers of the type having equidistant portions allotted for reception of discrete devices, wherein the mutual spacing of said equidistant portions matches the mutual spacing of devices on said conveyor means and in said rows, said transferring means including means for introducing successive rows into containers without altering the mutual positions of devices in such rows.

31. The apparatus of claim 20, wherein said conveyor means is arranged to advance the devices in a predetermined direction and said converting means comprises a suction head having an underside disposed above a predetermined portion of said path and means for advancing said suction head along an endless second path including a first portion wherein said underside is adjacent to said portion of said predetermined path and the suction head has a component of movement in said direction and a second portion, and means for attracting predetermined numbers of devices from said portion of said predetermined path to the underside of said suction head while the latter is disposed in said first portion of said second path, said transferring means including means for introducing the thus transferred row of devices from said suction head into a container while the suction head is located in the second portion of said second path.

32. The apparatus of claim 31, wherein the underside of said suction head has a row of equidistant flutes for discrete devices and said advancing means includes means for temporarily arresting the suction head in the second portion of said second path so that the suction head is at a standstill during transfer of a row of devices from its flutes into a container.

33. The apparatus of claim 20, further comprising means for transporting containers along a

second path having a portion wherein the containers move stepwise during intervals between introduction of successive rows of devices into their interior.

34. The apparatus of claim 33, wherein said transporting means comprises means for moving successive filled containers in the longitudinal direction of the devices which are confined therein.

35. The apparatus of claim 33, wherein said transporting means includes means for changing the orientation of successive filled containers.

36. The apparatus of claim 35, wherein said orientation changing means includes means for moving each filled container from an upright position in which the devices therein are substantially horizontal to a prone position in which the devices therein are substantially vertical.

37. The apparatus of claim 36, wherein said transporting means further comprises conveyor means for moving filled containers in a direction at right angles to the longitudinal directions of the devices therein.

38. The apparatus of claim 33, wherein said transporting means defines a filling station wherein the containers are filled with rows of rod-shaped devices and said transporting means further comprises means for delivering empty containers to said filling station.

39. The apparatus of claim 38, wherein said transporting means further comprises means for changing the orientation of empty containers not later than on arrival at said filling station.

40. A method of storing pluralities of substantially rod-like carrying devices for incipient plants in successive containers wherein the plants can be or are caused to grow, substantially as herein described with reference to the accompanying drawings.

41. Apparatus for storing pluralities of substantially rod-like carrying devices for incipient plants in containers wherein the plants can be or are caused to grow, substantially as herein described with reference to the accompanying drawings.

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